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QUARTZ PLATE MOUNTINGS AND TEMPERATURE CONTROL FOR PIEZO OSCILLATORS

During the past few years an extensive study of certain phases of piezo oscillator construction and performance has been made at the bureau. The oscillators studied have been those sent in for calibration and those built at the bureau to serve as frequency standards. In a report to be published in the October number of the Bureau of Standards Journal of Research the quartz plate mountings and the temperature-control units will be discussed.

The quartz plates commonly used are either rectangular or circular. For frequency standards the electrodes of the plate mounting should be so spaced: (1) that the air gap does not change with time; (2) that the air gap changes in a definite manner with variation in temperature; and (3) that all unessential electrical capacity is minimized. The shifting of the quartz plate between the electrodes must be as small as possible.

A simple type of holder, which is often used for rectangular quartz plates, consists of two brass electrodes with a celluloid or bakelite ring to limit partially the shifting of the quartz plate. The upper electrode may be adjustable as to air gap or may rest on the quartz plate. Since the quartz plate changes its position with any slight jar the frequency is ordinarily constant only to 1 part in 10,000 to 30,000.

A quartz bar may be held in position in the mounting by two screws mounted in the lower electrode in such a way that they engage in slots in its edges, one in each edge midway between the two ends. Bars mounted in such a manner are found to be constant in frequency to 1 part in 300,000.

Another method of mounting a long rectangular quartz plate to oscillate in its extensional mode is to clamp it centrally with respect to its ends between two narrow surfaces projecting from the electrode faces in such a manner that the narrow contacting areas are perpendicular to its length. Quartz spacers fix the air gap. This type of holder is very satisfactory for any plate whose extensional vibration frequency is below 100 kc. The constancy of frequency is about 1 part in 300,000.

A circular quartz plate is somewhat easier to mount satisfactorily than a rectangular one. A simple type of mounting for circular plates uses a piece of pyrex tubing, slightly larger in diameter than the quartz plate, to

serve as a spacer between the electrodes as well as to hold the quartz plate in place. The greatest possible constancy in frequency for a plate in such a mounting used in a portable standard is 1 part in 200,000.

For the "thickness frequency" a hole, tapering in from each face, may be cut along the cylindrical axis of the quartz plate. This decreases the temperature coefficient of frequency. The plate is then mounted on a horizontal bakelite rod passed through the hole. A pyrex ring serves to space the electrodes. Although a quartz plate mounted in this manner is not reliable in a portable standard, in a fixed position the frequency will be reliable to 1 part in 1,000,000.

It is possible to mount a circular quartz plate so that it will be reliable as a portable standard. About the cylindrical surface a V-shaped groove is cut halfway between the plane faces of the quartz plate. The plate is then mounted within a metal ring by three screws, 120° apart, whose tapered points fit in the groove to grip the plate. The metal of which the ring and screws are made should be chosen so that the expansion of the quartz plate is the same as the differential expansion of the ring and screws. Pyrex washers space the electrodes on each side of the quartz plate. In such a mounting the decrement is small and there is no chance of the quartz plate shifting in its mounting. The frequency of a portable standard using such a mounting will remain constant to 1 part in 1,000,000 with the oscillator circuit temperature-controlled.

The simplest type of temperature control consists of a small box of wood or similar material, containing the quartz plate, a thermostat, and electric heater. The relative locations of these various elements in the cabinet, and the type of thermostat determine the constancy of temperature control. A good bimetal thermostat will hold the temperature constant to 1° C.; a mercury thermostat will be probably ten times as constant.

The quartz plate may be placed inside a heat-attenuating box within the temperature-controlled compartment. This attenuating box may be of wood, or, better, of alternate layers of metal and felt or asbestos. Such attenuation ordinarily decreases the variations of temperature at the quartz plate to 1 per cent of that of the temperature-controlled space.

Where greater constancy of frequency is desired, the oscillator circuit must be maintained at constant temperature. It is more desirable to have a double temperature-control on the quartz plate, putting the oscillator circuit in the outer control compartment together with the attenuating box containing the inner temperature-controlled space and the mounted quartz plate.

A BALANCED THERMOCOUPLE AND FILTER METHOD OF ULTRA-VIOLET RADIOMETRY

At present the physician has neither a unit of dosage nor a meter for accurately measuring the amount of ultra-violet radiation used for healing purposes.

In the absence of an inanimate dosage meter the patient is used as an indicator, and the dosage is estimated by the erythema produced on some untanned part of the body, for example, the inner forearm, when exposed to the lamp. It is probable that this precautionary test of exposure to ultra-violet will always be made. However, in view of the wide variation in erythemic susceptibility of pigmented and unpigmented skin, burns are likely to be produced, and the search in progress, the world over, is for a simple device for accurately measuring the ultra-violet intensity of the source used for healing purposes. In this search, the Bureau of Standards and other research laboratories are taking an active part, particularly the bureau, in the problem of standardization of ultra-violet intensity or so-called dosage meters.

A paper which will be published in the October number of the Bureau of Standards Journal of Research (Research Paper No. 370) is a further contribution (see B. S. Research Paper No. 318) to the investigation of filter radiometry, with special reference to the quantitative measurement of the component of ultra-violet radiation, of wave lengths less than 313 millimicrons in sunlight and in artificial sources, which biologists recognize as of special importance in the prevention and cure of rickets.

The apparatus used was a balanced radiometer, consisting of a thermocouple in which the two receivers are simultaneously exposed to radiation, under which conditions practically no thermoelectric current flows through the galvanometer. A 1-centimeter cell of water or of crystal quartz was used

continuously over the thermocouple receivers.

On covering one receiver with a filter that excludes the ultra-violet which it is desired to evaluate and the other receiver with a window that freely transmits these ultra-violet rays, and exactly balances the transmission losses of the exclusion filter, throughout the remaining part of the spectrum, the galvanometer deflection obtained on exposure of the two thermocouple receivers through this combination of filters is a direct measurement of the ultra-violet emitted by the source under investigation. In order to evaluate the ultra-violet of wave lengths less than 313 millimicrons, it is necessary to know the relative spectral energy distribution of the source for wave lengths less than 400 millimicrons.

The ultra-violet exclusion filter was a barium flint glass and the balancing filter was of crystal quartz or Corex G980A, depending upon the source of radiation. The lack of complete balance of long wave length radiation was determined by covering both receivers with a plate of Noviol-A glass, which is opaque to radiation of wave lengths less than 400 millimicrons, the long wave length end point of absorption of the barium flint exclusion filter.

Using two arrangements of (1) the balanced pair of thermocouple receivers with a single exclusion filter method, and (2) a single thermocouple receiver with two exclusion filters (three methods in all); and (3) using two methods of calibrating the radiation sensitivity of the thermocouple receivers in absolute units, closely agreeing measurements were made showing that the average amount of ultra-violet radiation of wave lengths less than and including 313 millimicrons for midlatitude sea level stations, during the clearest weather, during midday in midsummer, amounts to about 90 microwatts per cm^2, decreasing to about 20 microwatts per cm^2 on the clearest days in midwinter.

An experimental procedure is described for testing the performance and for standardizing photoelectric cells, for use as ultra-violet intensity (so-called dosage) meters.

An experimental procedure is described for using measured amounts of spectrally pure ("monochromatic,") and of heterogeneous ("heterochromatic") ultra-violet radiation in physiological tests, such as, for example, the amount of ultra-violet energy required to produce a minimum perceptible erythema on the untanned human skin. Data are given showing the erythemogenic efficiency of Washington midsummer ultra-violet solar radiation is only about 21 per cent that of the wave length (297 millimicrons) of maximum erythemic susceptibility. Using the spectral erythemic response curve observed by the writers, the calculated erythemogenic efficiency is 22 per cent, which is as close an agreement as can be expected, in view of the uncertainty in the ultra-violet solar spectral energy curve upon which the calculations must be based.

Using an artificial source of radiation in which the ultra-violet spectral energy distribution and the total erythemogenic ultra-violet radiation could be accurately measured, the observed time of exposure to the total radiation from the lamp, required to produce a minimum perceptible erythema, was in good agreement with the time calculated from observations using the wave length (297 millimicrons) of maximum erythemic susceptibility.

SOLARIZATION AND REJUVENATION OF WINDOW GLASS

In previous reports (Technical News Bulletins Nos. 152, December, 1929; 160, August, 1930; 164, December, 1930) attention was called to the fact that short wave length ultra-violet radiation of wave lengths less than about 320 millimicrons in sunlight and in artificial sources have the property of decreasing the ultra-violet transmission of certain special glasses to a stabilized value. Further exposure of these glasses to radiation of wave lengths longer than about 350 millimicrons in the mercury arc and in sunlight (which are isolated by covering the glasses by filters of window glass, etc., that are opaque to the short ultra-violet rays) increases the transmission to an appreciably higher value. In one test the rejuvenated transmission under the filtered mercury arc was higher than that of a duplicate sample exposed to filtered sunlight. This is probably owing to the fact that after filtering the wave lengths shorter than 313 millimicrons from the radiation from the mercury arc but little remains other than the 365 millimicron line.

During the past summer these tests were repeated and verified, by exposure of the special glasses under: (1) Black paper, (2) quartz, (3) window

glass opaque to wave lengths less than 313 millimicrons, and (4) a filter of G584 glass that is opaque to wave lengths less than 340 millimicrons.

The heating under the black paper produced no change in transmission. The decrease in transmission under quartz was practically the same as unfiltered sunlight. The increase in transmission under window glass was less than under the blue-green filter G584 which verified previous tests showing that wave lengths in the region of 365 millimicrons have the greatest rejuvenating action.

Present experience indicates that the use of filtered radiation from the quartz mercury arc is less reliable than unfiltered radiation in making stabilization transmission tests. Inconsistencies reported by others may be owing to the fact that the natural solarization tests of the window glasses were made in the autumn and in January to March, when, owing to the low altitude of the sun, the shortest ultra-violet rays are absent and the stabilized transmission is not so low as is obtained in summer sunlight.

Stabilization tests requiring 200 or more hours exposure to filtered radiation are impracticable. Hence, as described in Technical News Bulletin No. 162 of October, 1930, the most reliable procedure is to stabilize the transmission by exposure to the unfiltered radiation from the quartz mercury arc lamp.

FUNDAMENTAL STANDARDIZATION OF COLORS

Because of their impermanence, material standards, such as glass filters or colored chips, can play only an auxiliary part in the standardization of color on a fundamental basis. The fundamental specification consists of a spectral distribution of energy, which is the immediate stimulus for the color, combined with the color-vision characteristics of the eye whose activity results in the color. The spectral distribution of energy taken alone is sufficient to insure the reproduction of the color, but, taken alone, it would be an unduly stringent specification because it would exclude many other distributions of energy which result in the same color. It is customary, therefore, to express color specifications in terms of a normal eye to which, for the sake of uniformity, all distributions of energy serving as color stimuli are referred. The "excitation" curves of the Optical Society of America, based on measurements taken by Abney and König more than 20 years ago, have been widely used in America to define the properties of a normal eye for the purposes of color standardization.

Recently a British investigator, Doctor Wright, has repeated for 10 observers the measurements of Abney and König, using improved apparatus and technique; but, because of the form in which the results were expressed, it has not been possible to compare his results with the O. S. A. "excitation" curves directly. The requisite transformations have now been carried out in the colorimetry section of the Bureau of Standards, and it is disclosed that Wright's results check those of Abney and König, except for differences which are not large compared to individual variations. It is concluded, therefore, that the slightly more faithful representation of normal vision afforded by Wright's data is not sufficient to justify the inconvenience of supplanting the present standard. However, the O. S. A. "excitation" curves have other defects which hinder their technical application more than their failure to give faithfully the characteristics of normal vision. It is possible that to remedy all these defects would make a change in these standard data worth while, even though subsequent projects in color standardization would have to be carried out on a basis not comparable to those already accomplished.

POROSITY OF ELECTROPLATED CHROMIUM COATINGS

Although chromium plating is very extensively applied to automobiles and other finished metal articles, it is well known that the chromium deposits are usually porous, and that the protection against corrosion of the base metal depends principally upon the quality of the nickel and copper coatings that almost invariably precede the chromium. In a research, made by the Bureau of Standards in cooperation with the American Electroplaters' Society, methods for detecting and evaluating the porosity of the chromium deposits were investigated, and the factors that influence porosity were studied.

Various methods that have been described for detecting porosity in chromium deposits were found to yield consistent results. The most generally applicable and reliable is the copper deposition method, which de-

pends on the fact that under certain conditions copper will not deposit on chromium, but only in pores or cracks in the chromium. This method was made semiquantitative by measuring either the average apparent current density or the weight of copper deposited in two minutes at 0.2 volt. The results represent the relative porosities. In order to determine whether a decrease in porosity of the chromium will result in an increased protective value, exposure tests are being made in cooperation with the American Electroplaters' Society and the American Society for Testing Materials. The following conclusions are therefore tentative.

Very thin deposits of chromium usually contain round pores. As the thickness is increased, these pores disappear, but cracks are formed, especially on standing. For the common conditions of deposition, the minimum porosity is obtained with a thickness of about 0.00002 inch, which is the usual thickness applied to automobile parts. If, however, the chromium is deposited at a higher temperature such as 65° C. (149° F.) instead of the usual temperature of 45° C. (113° F.), and at a suitable current density, the deposits are less porous than usual. This is especially true of thicker deposits.

The least porous deposits are produced on nickel, which is generally applied as a preliminary coating on other metals before chromium plating. Heating the deposits to 200° C. for a short time produces a greater porosity than if allowed to stand at ordinary temperature. Under the latter conditions the porosity gradually increases for two weeks.

If the results of these laboratory studies are confirmed by exposure tests, it may be possible to improve the protective value of the chromium coatings by using higher temperatures and sufficiently high current densities to produce bright deposits.

A complete report on this study will be published in the October number of the Bureau of Standards Journal of Research.

THERMOMAGNETIC PHENOMENA

Steel upon heating or cooling undergoes characteristic magnetic transformations which are associated with corresponding structural transformations. The observation of these magnetic transformations with special reference to their interpretation in terms of the corresponding changes in structure or condition has been termed thermomagnetic analysis.

In a paper before the September meeting of the American Society for Steel Treating in Boston, R. L. Sanford, of the bureau, discussed the characteristic magnetic phenomena which may be observed when steel is heated or cooled, and showed how they may be interpreted in terms of the corresponding structural transformations. Thermomagnetic analysis, on account of its great sensitivity, offers a means for studying some changes in the structure of steel which can be observed in no other way.

THERMAL EXPANSION OF FERROUS ALLOYS

With the cooperation of a number of steel companies and other manufactures of heat-resisting alloys there was recently completed at the bureau a comprehensive investigation on the linear thermal expansion of various commercial nickel-chromium, iron-chromium, and nickel-chromium-iron alloys. These alloys contain 0 to 77 per cent nickel, 5 to 27 per cent chromium, and 0 to 82 per cent iron. The coefficients of expansion of the alloys were determined for various temperature ranges between 20° and 1,000° C., and the effects due to temperature, chemical composition, heat treatment, etc., were determined. Critical regions were located on the thermal expansion curves of some of the alloys. The data which will be published later in the Bureau of Standards Journal of Research, are useful in several ways. It is possible to select heat-resisting alloys which have the same coefficients of expansion for a given temperature range as other materials, for example, brass, copper, porcelain, steel, etc., when assembled in equipment or appliances where differences in expansion would be undesirable. It is possible to predict the coefficients of expansion of similar new alloys. It is also possible to determine the heat treatment suitable for each type of alloy for a specific purpose as governed by the desired structure.

During the past year the coefficients of linear expansion of a number of samples of invar and related nickel steels were determined. These alloys were used in level rods, side bars for strain gages, elevator hoistway interlocks, etc., where low expansion is necessary. About 50 tests have been made during the year.

AQUEOUS SOLUTIONS FOR QUENCHING STEEL

Steel is an alloy with ability to develop properties covering a wide range of strength, hardness, and ductility. It is because of this versatility and adaptability that steel plays so important a part in modern life and industry. One of the most important duties of the metallurgist is to determine the treatments to which any given steel must be subjected to develop the properties needed in some particular service. The more common steels are made soft by cooling slowly from temperatures approximating a "red heat," and are hardened by cooling rapidly from these same temperatures.

Quenching, that is, cooling rapidly from a red heat by plunging metal into water or oil, is thus a fundamental process in heat treatments employed to develop enhanced properties in steel. The precise structure and hence properties produced in quenching are controlled by the speed at which the steel cools during the operation. Water and oil are the two most commonly used quenching media. Water produces the more rapid cooling effect, that is, a steel quenched in water is in general harder than if quenched in oil. Occasionally a water-quenched steel is too hard for the most satisfactory service. In such a case a tempering treatment is frequently necessary, which consists of reheating the steel after quenching to relative low temperatures.

A steel equivalent to or possibly better than the quenched and tempered steel would often be possible if quenching solutions were available possessing characteristic cooling rates between those of water and oil.

In a recent investigation at the bureau a study was made of aqueous solutions of ethylene glycol, glycerine, and sodium silicate to determine whether any of them offered promise as quenching media with characteristic cooling rates in this intermediate range. It was found that the solutions of glycol and of glycerine did not give results which were readily reproducible. Hence, such solutions do not appear promising for practical use. However, solutions of several concentrations of sodium silicate proved to have quenching rates in the desired intermediate range and to give very consistent results. Some of these sodium silicate solutions must be treated with small additions of caustic soda in order to prevent changes in them when allowed to stand for several months. The effect of varying the concentration and the temperature of the sodium silicate solution was studied. It was concluded that sodium silicate solutions give promise of usefulness in the quenching of steels by providing solutions having graded cooling rates between those of water and of oil.

A full report on this subject was published in the September number of the Bureau of Standards Journal of Research.

HEAT CONTENT OF FROZEN BRINES

In a refrigerating plant, the refrigeration is usually produced by expanding ammonia or some other refrigerant from a high to a low pressure. The low pressure gas, its temperature lowered by the expansion, then passes into the cooling coils. It is not always convenient to locate these coils at the point where refrigeration is desired, and consequently it is frequently necessary to transfer heat in some way from the objects which are to be refrigerated to the cooling coils. In an ice-making plant, for example, this is accomplished by immersing both the ice cans and the cooling coils in a liquid of low freezing point and circulating this liquid so that it flows over the cooling coils and around the ice cans. The liquids commonly used for this purpose are brines, or water solutions of various salts, among which are sodium chloride (ordinary table salt) and calcium chloride.

In designing or testing a refrigerating plant, the engineer requires a knowledge of the amount of heat absorbed by a unit weight of brine when it is heated from any given temperature to some higher temperature. Information of this kind, for brines at temperatures above their freezing points, has been available for some time. There have, however, been no readily available data of this nature which were applicable to frozen or partially frozen brines. As the result of a study of this subject at the bureau, methods have been developed for calculating the quantity of heat absorbed when 1 pound of a brine initially frozen or partially frozen is heated to any higher temperature. Using these methods, practical working tables suitable for use by engineers have been prepared. A report on this subject will be found on page 166 of "Refrigerating Engineering" for September, 1931.

WIND-PRESSURE TESTS ON EMPIRE STATE BUILDING

There was recently completed at the bureau a model of the Empire State Building, New York's tallest structure, for the purpose of studying wind loads. The model is constructed on a scale of 1 to 250, and is accordingly 5 feet high. On this scale the average human being would be a little over a quarter of an inch high. The model has been placed in the 10-foot wind tunnel and pressures developed by winds up to 60 miles per hour are being measured. The measurements will not be completed for several months.

It may appear strange that such measurements should be undertaken after the completion of the building, but because of unusual conditions this building offers an interesting opportunity to advance our knowledge of wind pressure. Through the cooperation of owners, architect, engineer, builder, and the research committee of the American Institute of Steel Construction, observations are in progress by the research committee on the wind velocity at the top of the Empire State Building, and the wind pressures developed at the thirty-sixth, fifty-fifth, and seventy-fifth floor levels. These observations in themselves will be of the greatest value.

The Bureau of Standards takes advantage of this opportunity to demonstrate the value of model testing in the determination of wind pressure. The great utility of model testing has been thoroughly demonstrated, especially in the fields of aeronautics and hydraulics. Thus the design of the new airship *Akron* was greatly facilitated by extensive model tests. Likewise, model tests have paid their cost many times in connection with water-power developments. In the field of wind pressure, the utility and validity of model tests have not as yet been adequately recognized, largely because of the absence of satisfactory comparisons between model and full-scale structure. The Empire State Building offers such an opportunity and will thus serve to give information to enable the construction of other, still taller, structures with economy and safety.

FIRE TESTS OF PARTITIONS

The evolution of modern types of fire-resistive building construction has brought about improvements in the use of the older building materials and the development of several new ones. Among these is a structural unit, introduced in Europe, the manufacture of which has recently been started in this country. This unit is made by thoroughly coating long wood shavings (excelsior) with a magnesium cement and molding the coated mass of fibers into the desired form. The cement coating serves the double purpose of flame proofing the wood and binding the fibers into a unit of the necessary degree of rigidity. Both insulating and building units are made.

Fire-endurance, fire, and fire-hose stream tests on plastered partitions of these blocks, 16 feet long by 11 feet high, were conducted recently in the bureau's wall-testing furnace. These partitions were built of blocks 3 inches thick and plastered on each side with approximately one-half inch of sanded gypsum plaster. The first of the test partitions was built of blocks manufactured in Europe. These blocks were 1.6 meters (63 in.) long by 0.5 meter (20 in.) high, by 7.5 cm. (3 in.) thick. This partition was reinforced with three No. 10 gage wires placed vertically on each side, at the center and quarter points of length, and anchored to the restraining frame of the furnace at top and bottom. Tie wires through the horizontal joints between courses bound the wires on the opposite sides of the partition together. These reinforcing wires were placed during the construction of the partition and covered in by the plaster. The other partitions were built of blocks of domestic make 48 inches long, 20 inches high, and 3 inches thick, set in the same manner, except that there was no wire reinforcement.

The partition built of European blocks and one built of domestic blocks were tested for fire endurance. The end point for each test was determined by rise of temperature at one of the nine thermocouples by which the surface temperatures were measured, this temperature being more than 30 per cent in excess of the general average of all the surface temperature measurements. The rise in each case was 181° C. (325° F.) above the initial temperature and was reached at 2 hours 12½ minutes and 2 hours 18½ minutes, respectively, in the two tests. The average rise of the temperature at the nine points was in each case much below the limit of 139° C. (250° F.) permitted by the standard fire test specification. In the first test this rise was 108° C. (194° F.) and in the second 90° C. (163° F.).

In neither case did the fire break through the partition subsequent to the fire test. In the first test, however, glow continued in the blocks for about 2½ hours after the furnace fire had been stopped, influenced to a large extent by the high temperature of the confronting furnace wall. The partition was removed from the furnace after 2 hours 24 minutes in the second test and subjected to a hose stream. The excelsior of the blocks in this test was found to have been charred to within one-half inch of the plaster on the unexposed side of the partition.

A partition built of blocks of domestic manufacture was subjected to fire for one hour and subsequently to impact and erosion effects of a fire hose stream from a 1⅛-inch nozzle on a 2½-inch fire hose, the pressure at base of nozzle and duration being approximately equivalent to 4⅖ minutes, application at a water pressure of 30 lbs./in.^{2} The partition withstood this test without passage of flame, hose stream, or unduly high temperature. In this test the wood shavings were charred to depths of 1¾ inches from the fire-exposed side of the units, but the average depth of char was approximately 1¼ inches. In a few small areas the stream eroded the block materials to within one-half inch of the plaster on the unexposed side.

As based on performance in these tests, this partition construction develops a fire resistance of 2¼ hours, combustible, as tested according to established procedure.

MASONRY CEMENTS

A study of masonry cements and mortars has been undertaken at the bureau. Certain hitherto unmeasured properties, such as plasticity, water-retaining capacity, and volume change, are being studied, and further workability, an essential property in masonry cementing materials, is being given particular attention. The compressive strength of 2-inch mortar cubes is also being determined.

Plasticity is measured in accordance with the principle employed in the McMichael viscosimeter—that is, shearing of the material by a fixed body in a rotated cup. The water-retaining capacity is measured by exposing one side of a thin slab of the mortar to a slight vacuum for various periods of time. This simulates the water-withdrawing action or "suction" of a brick.

Volume change is measured from the time the mortar is mixed, through long storage periods when stored both at 60–70 per cent relative humidity and inundated. Six specimens of the mortar are cast in a vertical manifold water-tight mold containing six 1 by 1 by 8 inch compartments with glass plates cast in each end of the specimen. Immediately after filling, the mold is placed under six dial strain gages—one gage for each specimen—by which the shrinkage is measured through the setting period. When the specimens have hardened sufficiently they are removed from the mold and placed in damp closet storage for one week after which they are subjected to the two storage conditions already described. Comparator measurements are made daily for the first week after removing from the molds, weekly for one month, and monthly from that time on. The cubes are made in three consistencies. They are stored one week curing in the damp closet, one week inundated, and finally one-half are placed in air at 60–70 per cent relative humidity, the other half being kept under water. Cubes are broken at 7 and 28 days, 3 months, and 1 year after the date of making.

The study of the interesting property of volume-yield has been added to the investigation. This includes density determinations of the masonry cements, both dry and in the neat mix. Certain devices for the measurement of the above-mentioned properties have been developed during the investigation and they are now being used on some 40 or more masonry cements now on the market.

PERFORMANCE OF AUGER MACHINE FOR EXTRUDING CLAY COLUMNS

The factors involved in the design of dies and augers for extrusion machines used in the manufacture of heavy clay products, are being investigated at the bureau. The experimental apparatus consists of a combined pug mill and auger machine of a very modern type. The various augers are interchangeable, and the dies are so constructed as to make possible any desired change in length, taper, or core design. A series of several extrusions is made with each change in set-up of auger or die. During the course of repeated extrusions, the moisture content of the clay decreases by evaporation, and moisture determinations are made on the clay used in each run, as well as a determination of the actual pressure required to extrude the clay at a definite rate from a closed cylinder. Thus, with both the moisture content

and "workability" of the clay determined, reasonably accurate comparisons of data from each series of extrusions can be made.

The total amount of power delivered to the assembly is measured as well as "power consumed" and "power developed" by the auger itself. This affords a means of comparison of the actual mechanical efficiency of any particular type of auger as well as its effect upon the production efficiency.

With the die and core combinations thus far used, the single wing auger has proven most efficient mechanically, with the double and triple wing augers following in order. However, the triple wing auger has been the most proficient from a production standpoint, extruding about 19 per cent more clay by weight than the single wing and about 23 per cent more than the double wing auger. But the power consumption when using the triple wing auger was 85 per cent in excess of that when using the single wing auger, indicating a considerably higher power cost per unit of production.

Variation in moisture content does not appear to have any marked effect upon the order of these comparisons, although an increase of 8 to 10 per cent in moisture of the clay will decrease the power required by the triple wing auger by more than that consumed by the single wing auger. However, the product is not quite so good in quality as that obtained with a stiffer clay-water mix. Throughout the change in moisture content the proficiency in production of the machine decreases as the moisture content decreases, while the actual mechanical efficiency of both the assembly and the auger alone increases as the moisture decreases.

CORRELATION OF SOIL CHARACTERISTICS WITH PIPE-LINE CORROSION

The experience of pipe-line operators has shown that severe corrosion of underground pipe lines may occur in certain kinds of soil. Recognition of the fact that soils differ widely in corrosiveness has led to investigations by the bureau for the purpose of identifying the corrosive soils and indicating their distribution. Since the most extensive oil and gas producing regions, as well as the more corrosive soils are found in the West and Southwest, investigations of soil corrosion in the past have been confined chiefly to those sections. However, the rapid expansion of natural-gas lines eastward has called attention to the need of more definite information on the corrosiveness of eastern soils, which differ greatly from the soils of the West. During 1929–30 a study of soil corrosion was made on a group of oil lines in Ohio, and the results should be of practical value to operators who are planning to extend their lines eastward through this area. Certain well-defined soil types were found to occupy the corrosive areas. This correspondence between soil type and corrosiveness suggests that the corrosiveness of other areas occupied by the same or related soils might be estimated by referring to maps prepared by the soil survey of the Department of Agriculture. Acidity appears to be the chief factor in the corrosiveness of soils. Determinations of the acidity of samples taken at various points along the lines showed that the corrosive soils were very acid and that the degree of acidity might be taken as a rough measure of their relative corrosiveness. A second test was made by measuring the extent to which a thin steel disc was corroded by moist soil in the laboratory, and the results in general agreed with the previous acidity tests. It is reasonable to conclude that a soil corrosion survey, prior to the laying of a pipe line in this region, would indicate the various areas where corrosion might be expected. Knowing the corrosive areas on his right of way, the pipeline operator would then be in a position to provide adequate protection for his line where it was most needed.

A more complete discussion of this work will be published in the October number of the Bureau of Standards Journal of Research.

CIRCULAR ON RECLAIMED RUBBER

Circular No. 393 on reclaimed rubber has just been issued and will be found of value to all those interested in the utilization of waste products.

While reclaimed rubber is not equal to new rubber in strength, stretch, and resistance to abrasion, it may be used successfully for many products in which softness and flexibility are important.

In manufacturing operations reclaimed rubber can be processed more readily and at less cost than crude rubber, but present reclaiming processes are not so well adapted to small-scale operation as are direct means of utilizing discarded rubber products. As is to be expected, the consumption

of reclaimed rubber fluctuates with the price of crude rubber, being high when the price is high and at a minimum when the price is low.

The two methods for reclaiming rubber, the alkali process and the acid process, are described. The majority of the reclaiming is done by the former process in which the ground scrap rubber is digested with sodium hydroxide solution and softeners under pressure to destroy the fabric, remove the free sulphur, and plasticize the rubber. The product is washed, dried, refined, strained, and sometimes compounded before marketing. It contains most of the constituents of scrap rubber, and in addition, softeners, fillers, and other substances which may be added during reclaiming.

Copies of this circular may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

NEW AND REVISED PUBLICATIONS ISSUED DURING SEPTEMBER, 1931

Journal of Research[1]

Bureau of Standards Journal of Research, vol. 5 (RP Nos. 183 to 258, inclusive), bound in cloth, $2.75 (foreign, $3.50).

Bureau of Standards Journal of Research, vol. 7, No. 3. September, 1931. (RP Nos. 348 to 360, inclusive.) Obtainable by subscription. (See footnote.)

Research Papers[1]

(Reprints from Journal of Research)

RP329. Soil-corrosion studies, 1930. Rates of corrosion and pitting of bare ferrous specimens. K. H. Logan and V. A. Grodsky. Price, 10 cents.

RP331. Apparent and partial molal heat capacities in aqueous solutions of 19 uni-univalent strong electrolytes. F. D. Rossini. Price, 5 cents.

RP332. Measurement of Lenard rays. L. S. Taylor. Price, 10 cents.

RP333. A new test for predicting the durability of varnishes (The photochemical embrittling test). J. H. Wilson. Price, 5 cents.

RP334. Interpolation of the O. S. A. "excitation" data by the fifth-difference osculatory formula. D. B. Judd. Price, 5 cents.

RP335. Experiments on the metering of large volumes of air. H. S. Bean, M. E. Benesh, and E. Buckingham. Price, 15 cents.

Circulars[1]

C393. Reclaimed rubber. A. T. McPherson. Price, 10 cents.

Commercial Standards[1]

CS29–31. Staple seats for water-closet bowls. Price, 5 cents.

Commercial Standards Monthly[1]

Commercial Standards Monthly, Vol. 8, No. 3, September, 1931. Price, 10 cents. Obtainable by subscription.

Technical News Bulletin[1]

Technical News Bulletin No. 173, September, 1931. Price, 5 cents. Obtainable by subscription.

LETTER CIRCULARS[2]

LC308. (Supersedes LC303.) Sound absorption coefficients of the more common materials.

LC309. Specifications for the repair of scales of large capacity.

[1] Send orders for publications under this heading with remittance only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Journal of Research, $2.75 per year; other countries, $3.50. Subscription to Commercial Standards Monthly, $1 per year; other countries, $1.25.

[2] "Letter circulars" are in mimeographed form and are designed primarily to answer specific inquiries. The supply is necessarily limited so that in general but one copy can be sent in answer to each request. Copies are available only on application to the National Bureau of Standards, Washington, D. C. No mailing list is maintained for "letter circulars," and complete sets of back numbers can not be furnished.

OUTSIDE PUBLICATIONS[1]

A course indicator of pointer type for the visual radio range beacon system. F. W. Dunmore; Proceedings, Institute of Radio Engineers (New York, N. Y.), p. 1579; September, 1931.

Standards for dental materials. N. O. Taylor; Reprint of paper before the Michigan State Dental Society (Detroit, Mich.), April 29, 1931, and Iowa State Dental Society (Des Moines, Iowa), May 4, 1931.

Heat control of frozen brines. R. S. Jessup; Refrigerating Engineering (New York, N. Y.), vol. 22, No. 3, p. 166; September, 1931.

Construction, equipment and maintenance of buildings in their relation to protection of records. S. H. Ingberg; Proceedings, 35th Annual Meeting, National Fire Protection Association (Boston, Mass.), p. 227; 1931.

Airplane fuel-line temperatures. O. C. Bridgeman; Society of Automotive Engineers Journal (New York, N. Y.), Vol. XXVIX, No. 2, p. 121; August, 1931.

Spectrophotometry at the Bureau of Standards. K. S. Gibson; Journal, Optical Society of America (Ithaca, N. Y.), vol. 21, No. 9, p. 564; September, 1931.

Interpolation of the O. S. A. "Excitation" data by the fifth-difference osculatory formula. D. B. Judd; Journal, Optical Society of America (Ithaca, N. Y.), vol. 21, No. 9, p. 531; September, 1931.

X-ray protection. L. S. Taylor; The American Journal of Roentgenology (Springfield, Ill.), Vol. XXVI, No. 3, p. 436; September, 1931. Reprint of Bureau of Standards Handbook No. 15.

A lead-lined safe for storing large amounts of radium. L. F. Curtiss; Radiology (St. Paul, Minn.), vol. XVII, p. 529; September, 1931.

The definition and determination of "free cyanide" in electroplating solutions. W. Blum; Preprint of paper before the Electrochemical Society (Columbia University, New York, N. Y.), September 2–5, 1931.

The deterioration of chestnut and quebracho tanned leathers by sulphuric acid. R. C. Bowker; Journal, American Leather Chemists Association (Easton, Pa.), Vol. XXVI, p. 444; September, 1931.

An investigation of cotton for parachute cloth. W. D. Appel and R. K. Worner; National Advisory Committee for Aeronautics (Washington, D. C.), Technical Note No. 393, September, 1931.

The wear of metals. L. Jordan; Mechanical Engineering (London, England), vol. 55, p. 644; September, 1931.

Quenches, intermediate between oil and water. T. E. Hamill; Metal Progress (Cleveland, Ohio), vol. 20, No. 3, p. 53; September, 1931.

The selection of durable aggregate for concrete. M. Temin, W. Pigman, and J. Tucker, jr.; Rock Products (Chicago, Ill.); August 1, 1931.

Some effects of thermal shock in causing crazing of glazed ceramic ware. H. G. Schurecht and D. H. Fuller; Journal, American Ceramic Society (Columbus, Ohio), vol. 14, No. 8, p. 565; August, 1931.

Metal marking of whiteware glazes as influenced by sulphur and carbon in kiln atmospheres. R. F. Geller and A. S. Creamer; Journal, American Ceramic Society (Columbus, Ohio), vol. 14, No. 9, p. 624; September, 1931.

Volume changes in brick masonry materials. L. A. Palmer; Journal, American Ceramic Society (Columbus, Ohio), vol. 14, No. 8, p. 541; August, 1931.

The weathering of structural clay products: A review. J. W. McBurney; Proceedings, American Society for Testing Materials (Philadelphia, Pa.), vol. 31, Part II, 1931.

Simplification of food service equipment. W. E. Braithwaite; Institutional Jobber (New York, N. Y.); October, 1931.

The romance of measurement. H. D. Hubbard; The Scientific Monthly (New York, N. Y.), vol. XXXIII, p. 356; October, 1931.

[1] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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